November 5th - 6th, 2008

Student's Name: **Period #:**

Instructor: Ray Migneco

Introduction

In this activity you will learn about the factors that determine why a musical instrument sounds a certain way. For example, if a violin and a trombone are each playing the same note (musical pitch) at the same volume for the same length of time, what makes them sound different? At the end of this activity, the term that describes the "way a sound *sounds*" is known as *timbre*. In order to analyze the timbre features of musical instruments, we'll be using an online game called ToneBender that allows you to modify musical instrument sounds and identify the musical sounds created by other players.

Setting Up

1. Make sure you have a set of headphones
2. Make sure that you're computer's volume is set at a reasonable level. Test using the keys at the top of the keyboard
3. Open up the FireFox web browser on your computer
4. Your homepage should be set to the METlab homepage. Find the link for **ToneBender** on the page and click it. (http://schubert.ece.drexel.edu/~raym/ToneBender/ToneBender.php)
5. Click the **Create Account** link and fill out the form with your information. **Remember your Username and Password!**
6. Use the login form to sign in with the **Username** and **Password** you just created
7. Select the **Create** link to begin
8. Read on before using the interface

Exercise 1: Understanding Loudness Over Time

You are now presented with an interface that allows you to analyze and modify musical instrument sounds, as shown in the figure below (your instrument may be different from the one shown).

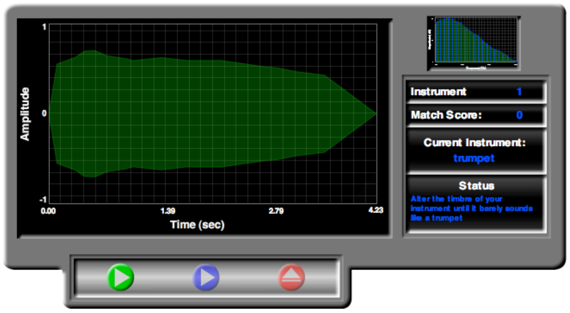

Figure 1: Instrument Creation Interface

Controls Description:

Green Curve: A curve that represents the loudness of the original instrument

Green Button: Allows you to listen to the original (unchanged) instrument

Blue Button: Allows you to listen to your changed (modified) version of the instrument

Red Button: Submits your instrument to a database for storage and evaluation

1. Press the **Green Button** to listen to the original instrument. Notice how the loudness of the instrument follows the **Green Curve** from left to right. For example, an increase in volume is indicated by an increase on the **Green Curve**.

2. Now that you're more familiar with the interface, we'll be able to start. Using your mouse, draw your own loudness curve on the screen by clicking and dragging. You'll notice that your curve shows up in **blue**. An example is shown in the figure below.

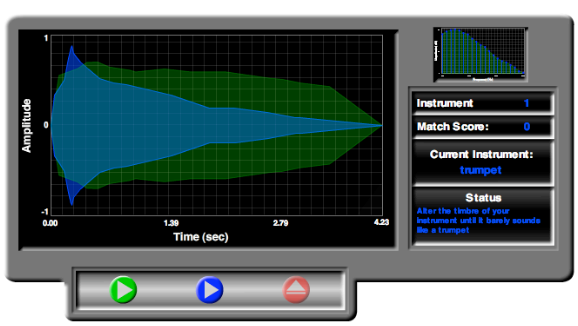

Figure 2: Example of drawing a loudness curve

3. By pressing the **Blue Button**, we can listen to how our drawn loudness curve changes the way the instrument sounds.

4. Be creative! Experiment with several different curves and observe how the curve affects the loudness of the your instrument.

Notecard Question 1

(Stop here and answer the instructor's question on the notecard provided to you)

5. Draw a loudness curve for your instrument so that it is a reversed version of the Green Curve. For example, if it suddenly increases in loudness and gradually becomes softer, draw a curve that gradually becomes louder and gets soft very fast. Answer the question below.

Response Question 1:

Compare your reversed sound to the original by listening with the Green and Blue buttons. Do you think your instrument sounds similar or different from the original? Explain the relationship between the shape of the loudness curve and how fast the loudness of the instrument changes.

Exercise 2: Understanding Overtones

The previous exercise demonstrated how the sound of a musical instrument depends on how the loudness of the instrument varies over the duration of the note. However, loudness is just one aspect of *timbre*. Now we will consider another timbre property, namely the *overtones* contained in a sound.

1. Using your mouse, draw a loudness curve that is approximately the same as the **Green Curve**. It does not need to be exact, but as close as you can get with the mouse.

2. Click on the small window in the top right corner of the instrument analyzer. This action will switch between the loudness screen and the overtone screen, by minimizing one screen and maximizing the other. Your screen should be similar to Figure 3.

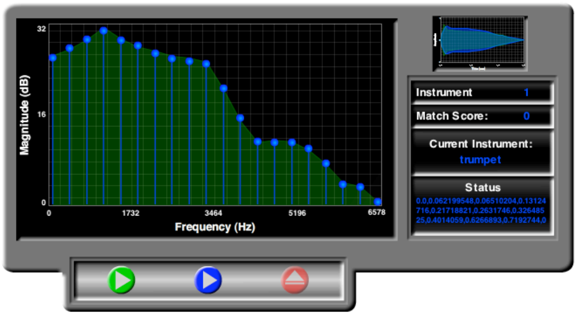

Figure 3: Overtones of the Instrument

The blue dots in the figure represent the most dominant overtones in your musical instrument. Before explaining overtones in detail, we'll do a simple experiment to help you understand the impact of overtones on the timbre of your instrument.

3. Press the **Blue Button** to listen to your instrument and take note of how it sounds.
4. Reduce the strength of all the overtones **except** the leftmost blue dot by clicking and dragging down with your mouse as in the figure below. We'll call this overtone the **fundamental**.

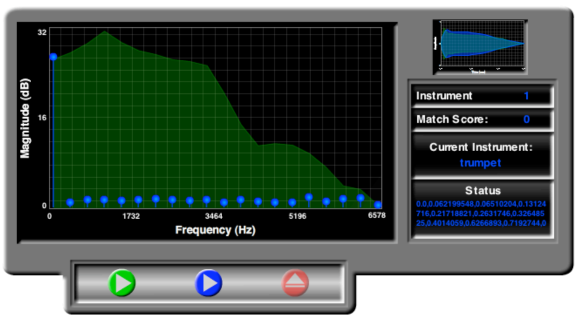

Figure 4: Reducing all the overtones except the fundamental

5. Using the **Green** and **Blue Buttons**, compare the way your instrument sounds (with just the left most blue dot) compared to the original. Think about what is similar or different about the way they sound.
6. Now repeat the process with the next blue dot, your screen should look similar to the figure below. We'll refer to this blue dot as the **first overtone**. Use the buttons to compare the way the both instruments sound.

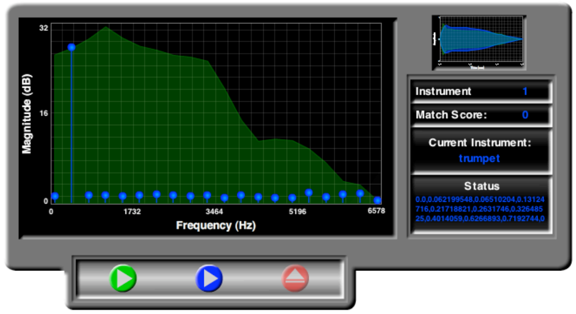

Figure 5: Reducing all the overtones except the first overtone

7. Repeat the process one more time using the next blue dot on the screen so that your screen looks similar to the one in the figure below. This raised blue dot is the **second overtone**.

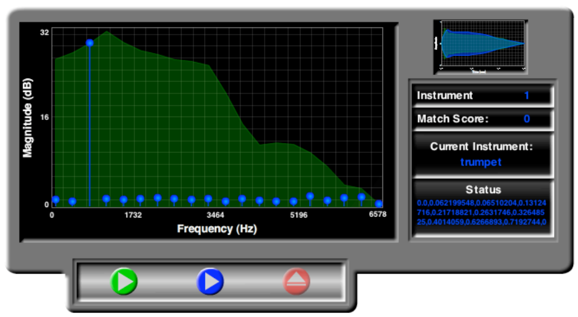

Figure 6: Reducing all the overtones except the first overtone

8. Now begin increasing the strength of **all** the overtones (blue dots), one by one, until you've positioned them all into their original positions using the **Green Line** as a guide. As you adjust each overtone, compare the sounds using the **Blue** and **Green Buttons**. When you finish, the two instruments should sound very similar.

Notecard Question 2

(Stop here and answer the instructor's question on the notecard provided to you)

Response Question 2:

In the previous exercise you were able to isolate specific overtones and listen to the resulting sound. Did the instrument sound musical or nonmusical when you isolated certain overtones? How would you explain how the overtones "work together" in determining the overall sound you hear?

In the previous activity, you may have noticed the *frequency* labels on the screen. These provide an indication of the frequency of each overtone. As you may know, *frequency* in sound describes how fast the air is vibrating, which is related to pitch (faster vibration leads to higher pitched sounds).

We also notice from the screen that the spacing between most of the overtones(blue dots) is about the same. This spacing is equal to the fundamental tone's frequency (the leftmost Blue Dot). Another way of thinking about this is that the overtone frequency is related to the fundamental by some whole number (2,3,4, etc.) multiplied by the fundamental frequency. This relationship explains why the overtones sound "good" together when they're in their original positions.

Exercise 3: Timbre Exploration

The previous two exercises introduced you to two different ways of manipulating the timbre for a particular musical instrument. Now we'll manipulate timbre of various musical instruments.

1. Your objective now is to take the instrument provided by ToneBender, and modify the sound as much as possible while **still maintaining the instrument's identity**. This means, for example, if you change the timbre of a guitar, it should still "sound like" a guitar to you.
2. For each instrument, you may choose to modify the loudness over time, the overtones or both. Remember that clicking the window in the top right corner will switch between the views.
3. When you are satisfied with your modifications, use the **Red Submit Button** to send your instrument to the database and retrieve another.
4. After modifying 5 instruments, a summary of your created instruments will be provided. Click the **Main Menu Button** to return to the main page.

Response Question 3:

After experimenting with several instruments, what do you think the role of the loudness curve is in music instrument identification? Do you think it provides any indication on how the instrument is played (i.e. plucked, bowed, blown, etc.)? What role do you think the overtones play in determining the identity of a musical instrument? Do they have any effect on how bright or dull the instruments.

Congratulations! You've mastered manipulating timbre of musical instruments! Now you can evaluate the sounds of instruments other players have created. From the main menu, select "Listen" and try to identify as many instruments as accurately as possible to achieve a high score!